Comparison of the Survival Rates between Migratory and Resident Birds

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Abstract:

Knowledge of survival rates is critical for understanding population change for any species. Migratory species may have lower survival rates than resident species due to the physiological stress of migration and movement through unfamiliar habitat. In this study, we compared the apparent annual survival rate of migrant Gray Catbirds (*Dumetella carolinesis*) and resident Northern Cardinals (*Cardinalis cardinalis*). We analyzed eight years (2010-2017) of bird banding data in west-central Ohio using robust design mark-recapture analyses. We caught 51 individual Northern Cardinals and 146 individual Gray Catbirds. Survival varied from year to year, and Gray Catbirds had a marginally higher survival rate as compared to Northern Cardinals. Lastly, we saw differences in species regarding to emigration, immigration, and capture probability, with Northern Cardinals having higher values than Gray Catbirds. Contrary to other studies, our study found that migrants had a higher annual survival rate compared to residents, but the relationship was weak. Future studies should seek to determine what environmental variation may lead to yearly differences in survival.

Introduction

Knowing survival rates is critical to understanding population change for any species. Moreover, knowing age-specific variation in mortality is key to understanding different rates of maturation and age-specific reproductive efforts (Becker et al. 2017). For example, fledglings have high mortality rates in the first few weeks of their lives, whereas birds that reach adulthood have lower mortality rates (Perlut and Strong 2016). Therefore, reliable estimates of survival rates typically require accurate aging of individuals and several years of data (Sillett and Holmes 2002). Estimating survival rates of adults is challenging because the failure to re-sight marked individuals could mean the bird was present but was not detected, the bird temporarily or permanently emigrated, or that the bird died (Becker et al. 2017).

Migration is a life history strategy prominent in birds that may have a profound impact on survival rates. Migration is an annual movement between two or more locations, and is thought to have evolved to maximize fitness in seasonal environments (Ely and Meixell 2016) and reduce competition (Lincoln 1935). Therefore migrating avian species exploit seasonal peaks of resource abundance and avoid seasonal resource depression (Alerstam et al. 2003). Proximate factors favoring migration include harsh climatic conditions or avoidance of predation, parasites, and diseases (Shaw and Couzin 2013). For example, the seasonal climate of the Northern hemisphere, associated pulses of food, and longer day length provides birds with enough resources to feed their young in a manner that triggers rapid growth with short exposure to predation (Lincoln 1935).

The energetic cost of long migration is undeniably high as migrants must balance between using energy for flight and storing reserves for reproduction (Ely and Meixell 2016, Klaassen 1996, Alerstan et al. 2003). Therefore, the energy cost of migration can have a negative impact on foraging efficiency due to the increased risk of injury, illness, and predation (Klaassen 1996). In fact, Sillett and Holmes (2002) found that most mortality occurs during the migration episodes with an apparent mortality rate 15 times higher during migration compared to stationary periods. If migration is costly, then we would expect migrants to have lower survival rates than non-migrants.

Another reason why resident birds may have higher survival than migrants is their familiarity with the location. Grist et al. (2017) attributed the higher survival rate for residents was attributed to the resident's ability to occupy high-quality territories in breeding areas as compared to migrants. Furthermore, resident individuals have a competitive advantage due to local territoriality, knowledge of sites, timing of arrivals or a combination of these factors (Drent et al. 2003).

Contrary to the expectation that migrants would have lower survival than residents, some studies have found that migrants tend to have higher annual survival than residents (Zuniga et al. 2017). Resident birds in North America must be able to withstand frigid winters. Adult winter survival rates were high during mild winters, and lower for harsh winters (Duriez et al. 2012). If residents struggle during harsh winters, then we would expect residents to have lower survival than migrants.

I compared the survival rates between the migrant Gray Catbird *(Dumetella carolinesis)* and resident Northern Cardinal *(Cardinalis cardinalis)*. I predicted that Northern Cardinal would have a lower survival rate compared to the Gray Catbird based on the harsh winters found in Ohio and the relatively short distance that catbirds migrate.

Methods

Study Species

The Gray Catbird, *Dumetella carolinesis,* is a migrant songbird with a broad wintering range from the southern New England coast south to Panama (Halkin and Linville 1999). Gray Catbirds breed east of the Rocky Mountains to the east coast, with migrant population wintering along Gulf of Mexico. Catbirds are commonly found in habitats consisting of dense shrubs or vine tangles, shrub-sapling-stage successional and edge habitats (Halkin and Linville 1999). Their diet consists of fruits and insects (Smith et al. 2011).

Northern Cardinals, *Cardinalis cardinalis,* are year-round residents distributed in the U.S and Canada with their range extending north to southwest (Halkin and Linville 1999). Their diet consists of seeds, fruits, and insects (Halkin and Linville 1999). Northern Cardinals are commonly found in habitats consisting of shrubs, small trees, forest edges and interior, marsh edges, grassland with shrubs, shrubby areas in logged and second-growth forests and successional fields (Halkin and Linville 1999).

Field Methods

This study utilized eight years (2010-2017) of mark-recapture data in west-central Ohio. The study was conducted on The Ohio State University Lima Campus in Lima, Ohio, in the Tecumseh Natural Area (40° 44' N / 84° 1' W). Most of this 200-acre woodland is oak-hickory with some maple.

All birds were banded during the months of May through September using ten mist nets. The four-tiered mist nets are 12 meters long with 30mm mesh and measure 2.6 meters high. All nets were placed so moderate vegetation was present on both sides. Nets were opened once every other week at sunrise and left open for approximately four hours after sunrise. They were checked every 40 minutes. The birds were captured and banded using USGS federal aluminum bands. Birds were identified, sexed, aged, banded and released. Time of day and net location were also recorded. To keep the data unbiased, only the first capture within a day was used for recaptured birds. However, individual birds that were recaptured on subsequent days were included in the analysis.

Data were analyzed using robust design models in Program MARK (version 9.0). Within those eight years, there were five occasions per year amounting to 40 days of banding. We compared survival rate with time, group (Northern Cardinal and Gray Catbird), age class (time interval between first and second encounter vs time intervals of all subsequent encounters), and their interactions. Emigration and Immigration were calculated in Program MARK. Emigration was modeled with group, time, and age class. Immigration, detection probability (ρ), and Huggin's c were modeled with group. Models were selected by first varying survival, then emigration, then immigration, then detection probability, then Huggin's c. After determining the most supported variables for emigration, immigration, detection probability, and Huggin's c, survival was varied again to verify model support. Means are given with their SD. Lastly, when ΔAIC ≤ 2, we considered the models equally plausible.

Results

From 2010-2017, 51 Northern Cardinals and 146 Gray Catbirds were caught. Given that a bird was captured in more than one year, the average number of recaptures was 1.17 ± 0.05 for Northern Cardinal and 1.14 ± 0.03 for Gray Catbird. A total of 9 Gray Catbirds and 3 Northern Cardinals were recaptured in two separate years. A total of 1 Gray Catbird and 2 Northern Cardinals were recaptured in three separate years. Lastly, there was one Gray Catbird that was recaptured four times within a year.

Three models were equally plausible (Table 1), and included a constant Huggin's c and a group effect (Northern Cardinal vs. Gray Catbird) for immigration, emigration, and detection probability. The difference among the three models was the effect on survival, with model 1 showing an effect of time, model 2 showing a constant effect, and model 3 showing a group effect (Northern Cardinal vs. Gray Catbird; Table 1). There was variation among the years with 2011, 2012, 2013 and 2017 having low survival rate for both species, and 2014, 2015 and 2016 having a higher survival rate for both species (Figure 1). Additionally, Northern Cardinals consistently had lower survival rate compared to Gray Catbirds (Figure 1). Northern Cardinals had higher rates of emigration, immigration, and detection probability (0.51± 0.28, 0.77± 0.43, 0.23± 0.10 respectively) as compared to Gray Catbirds (0.08± 0.22, 0.14± 3.75, 0.03± 0.02, respectively).

Figure 1: Survival rate ± SD comparison between Gray Catbirds (triangles) and Northern Cardinals (circles) and from 2010-2017.

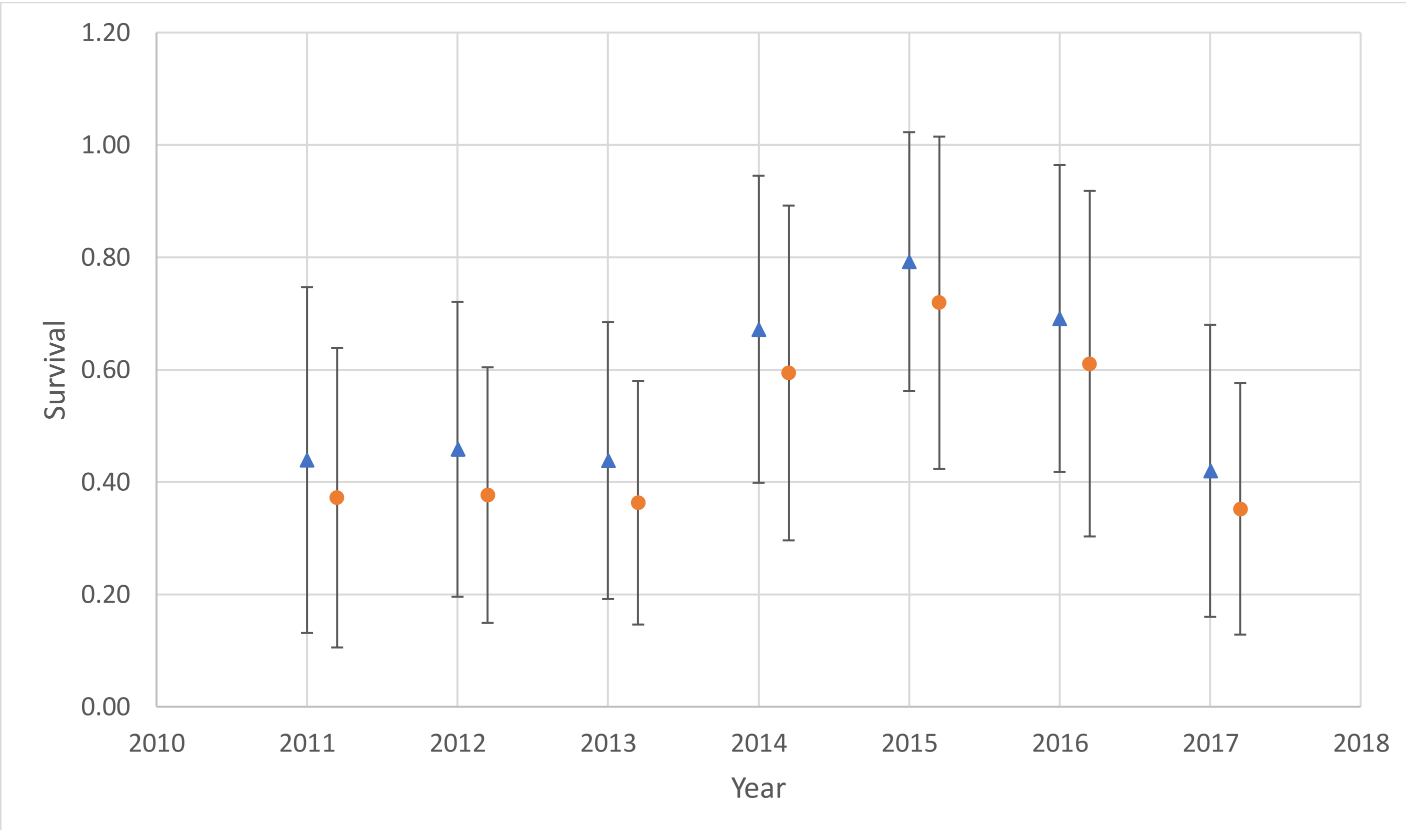

Table 1: Results of a robust design model comparing [survival rate] between Gray Catbirds and Northern Cardinals in Lima, OH.

Model	Survival	Emigration	Immigration	ρ	c	Model Likelihood	Deviance	# of Parameters	AICc	Delta AICc	AICc Weights
1	t	g	g	g	.	1.00	508.80	14	1130.40	0	0.28
2	.	g	g	g	.	0.80	522.41	8	1130.84	0.44	0.23
3	g	g	g	g	.	0.40	521.68	9	1132.25	1.85	0.11
4	t	g	g	g	g	0.33	508.73	15	1132.59	2.19	0.09
5	2ac	g	g	g	.	0.33	522.05	9	1132.62	2.22	0.09
6	g	g	g	g	g	0.14	521.61	10	1134.35	3.95	0.04
7	t	g	.	.	.	0.09	518.03	12	1135.16	4.76	0.03
8	t	.	.	.	.	0.07	520.66	11	1135.59	5.19	0.02
9	g*ac	g	g	g	.	0.07	520.69	11	1135.63	5.22	0.02
10	.	.	.	.	.	0.07	533.61	5	1135.69	5.29	0.02
11	g*t	g	g	g	.	0.06	498.28	21	1136.12	5.72	0.02
12	t	g	g	.	.	0.05	516.85	13	1136.21	5.81	0.02
13	ac	.	.	.	.	0.03	533.26	6	1137.44	7.04	0.01
14	t	ac	.	.	.	0.03	520.63	12	1137.77	7.37	0.01
15	g	.	.	.	.	0.03	533.60	6	1137.78	7.37	0.01
16	ac*t	g	g	g	.	0.01	505.20	20	1140.65	10.25	0.00
17	ac*g	.	.	.	.	0.01	532.56	8	1140.98	10.58	0.00
18	g*t	.	.	.	.	0.00	511.07	18	1141.83	11.42	0.00
19	ac*t	.	.	.	.	0.00	516.82	17	1145.26	14.86	0.00
20	t	t	.	.	.	0.00	517.02	17	1145.46	15.06	0.00
21	ac*g*t	g	g	g	.	0.00	492.09	33	1160.17	29.77	0.00
22	g*ac*t	.	.	.	.	0.00	503.92	30	1164.14	33.74	0.00

Model abbreviations are as follows: . =constant for all variables, g=group (Northern Cardinals, Gray Catbirds), t=time, ac=age class, *=interaction, ρ=detection probability, c=Huggin's c, AICc=Akaike information criterion corrected for small sample sizes.

Discussion

My prediction that Northern Cardinals would have a lower survival rate compared to the Gray Catbird received weak support. However, we found strong evidence that survival varied from year to year. We also saw differences in species regarding emigration, immigration, and capture probability, with Northern Cardinals having higher values than Gray Catbirds.

Survival rate of migratory and resident birds can be affected by environmental conditions. Duriez et al. (2012) concluded that the survival rate of migrant and resident populations of the same species were differently affected by harsh winters on the wintering grounds. Contrary to this, our study observed that environmental conditions affected both migratory and resident species equally because their survival fluctuated in unison from year to year. Although we do not test what environmental conditions affected survival, possibilities include prolonged droughts during the breeding season. Also, changes in annual survival could be attributed to food shortages during breeding seasons (DeSante et al. 2001).

More support has been found for migrants having a reduced survival compared to residents (Duriez et al. 2012, Rockwell et al. 2016, Sandercock and Jaramillio 2002, Rotics et al. 2017, Sillett and Holmes 2002). Such trends were associated with limited food present during harsh winter for overwintering birds (Duriez et al. 2012, Rockwell et al. 2016, Sandercick and Jaramillio 2002). Additionally, human-induced habitat loss on wintering and staging sites contributed to reduced migrant survival (Duriez et al. 2012). Lastly, carry over effect played a key role in migrant survival. In other words, migrants enduring harsh winters deplete their body reserve quickly causing migrants to show up to breeding grounds in poor conditions, risking higher mortality (Duriez et al. 2012, Rockwell et al. 2016). Contrary to these studies, several other studies, including our study, showed that annual survival rate for migrants were higher than resident (Zuniga et al. 2017, Gillis et al. 2008), although the relationship in our study was weak. Lower survival of resident birds is associated with defense of permanent territory by imposing direct energetic costs hindering their ability to gather and search for winter resources (Zuniga et al. 2017). Only one study found similar survival rates between resident and migratory species (Murphy et al. 2017). Trends such as reduced migrant survival compared to residents is attributed to the size of the migrating bird. In other words, larger birds are more susceptible to predation during migration. Therefore, it is more likely to see migrants having a reduced survival rate compared to resident. Reduced resident survival rate compared to migrant can been seen when human-induced habitat destruction of local territory is done.

Our survival estimates of cardinals and catbirds are similar to the 30-50% survival reported in other studies (Wolfe et al. 2013, Evans et al. 2015). However, we did not account for sex in our study, which is a possible confounding factor that is important in some studies. For example, Sillett and Holmes (2002) found that male black-throated blue warblers, *Darantasia caerulescens,* had higher annual survival than females on New Hampshire breeding grounds, while sexes had equal annual survival on wintering grounds in Jamaica. Contrary to this, Perlut and Strong (2016) showed limited support for an effect on sex on apparent survival. Furthermore, Zuniga et al. (2017) found no evidence for sex differences in survival. Concerning our study species, sex difference was found for Gray Catbirds where males had a higher apparent survival compared to females, but apparent survival was similar between sexes for Northern Cardinals (Evans et al. 2015). Therefore, future studies should look at sex difference in species and environmental variation which may lead to yearly difference in survival.

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